The development of guidelines for the design and evaluation of warning signs for young children

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ABSTRACT

We report a study which aimed to provide further development and refinement of a set of guidelines (Waterson et al., 2012) for the design and evaluation of warning signs and other visual material for young children (i.e., aged 5–11 years). The study involved a set of semi-structured interviews and focus groups with the parents of young children, teachers, human factors experts and other groups (n = 38). The findings from the study provided broad support for the guidelines, as well as highlighting a number of issues which need to be addressed. These included the need to consider the target audience in more detail and provide additional guidance covering possible tie-ins with safety campaigns, sign location, age differences, gender and children's special needs. Similar findings were obtained with regard to the evaluation guidelines and their coverage of methods and activities for testing signs (e.g., simulation, role playing). We discuss our findings within the context of a revised set of guidelines and a set of suggestions aimed at working towards a more comprehensive approach to the design/evaluation of signs for young children. The paper concludes with a set of future topics for research including a discussion of ways forward in terms of improving support for design and evaluation including behavioural testing with children, their parents and other care givers.

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1. Introduction

Drives to reduce the number of accidents which happen to young children represent a major challenge for safety organisations and governments around the world. Every year within the UK one million children under the age of 15 experience accidents of varying degrees of severity in or around their home environments (RoSPA, 2012). Those most at risk from a home accident are children between the ages of 0–4 years (UK Consumer Safety Unit, 2002). A significant number of minor injuries occur in a number of other contexts involving young children (e.g., rail travel – RSSB, 2009). One way of reducing the number of these accidents is the design of warning signs and other types of visual information which can alert young children and their carers to the dangers or hazards involved in hazardous environments or potentially unsafe behaviours.

Our aim in this paper is to outline our attempts to work towards a set of guidelines for the design and evaluation of warning signs for young children. In this paper we refer to 'young children' as children between the ages of 5 and 11 years of age. The work draws on the previous findings of Waterson et al. (2012) and a set of

interviews and focus groups with the parents of young children, teachers and professional book illustrators and authors. In what follows, we first review previous research which has examined the design and evaluation of warning signs for young children, alongside work addressing the types of methods which have been used to carry out research with children under the age of 11.

1.1. The design of visual warning signs for young children

Very few guidelines or standards for the design of warning signs and other materials exist for the children under the age of 11 years (Waterson et al., 2012). This stands in contrast to information of this kind which is available for adults (e.g., BSI, 2002; ANSI, 1998), as well as guidance developed for specific groups of individuals (e.g., visually impaired and other types of disabled users – Barker and Fraser, 2000). A key lesson from the available literature is that because of the limited cognitive abilities of children, particularly the very young, warnings need to be designed very differently as compared to those targeted at adults (Rice Berg and Lueder, 2008). Kashler and Wogalter (2008) suggest that some aspects of guidelines aimed at adult populations can be adopted for use with younger children, these include: the need to make warning 'stand out' (e.g., using bright colours and contrasts); and the use of pictorial symbols (e.g., pictograms).

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Table 1
Summary of the design guidelines developed by Waterson et al. (2012).

Guideline	Sub-component	Details
1. Design prototyping	(i) Preparation	Pilot, test and evaluate your methods thoroughly
	(ii) Design and evaluation	Be prepared to be surprised by what you find (they may contradict your assumptions)
2. General format	(i) Type of signs	Design the sign with objectives and context of use in mind
3. Textual aspects	(ii) Language	Keep the language used in signage as simple as possible.
	(iii) Number of words	Use a minimum of words
	(iv) Use of terminology, concepts	Avoid 'abstract' concepts or terminology
	(v) Fonts and lettering	Use large font sizes and consider the use of uppercase lettering
4. Visual aspects	(i) Pictograms	Use pictograms where possible to reinforce the safety message
	(ii) Examples	Use examples of pictograms that demonstrate 'good' and 'bad' behaviour
	(iii) Symbology	Use symbology that appeals to children
	(iv) Characters	Use safety characters to help convey the safety message
	(v) Colours	Use colours to reinforce the safety message

Waterson et al. (2012) carried out a study in collaboration with the UK Rail Safety and Standards Board (RSSB), the aim of which was to develop an outline set of guidelines covering the design and evaluation of warning signs (Table 1 shows a summary of the guidelines as they relate to design). The guidelines were based on a set of classroom discussions with groups of children aged between 5 and 11. One of the conclusions from this work was the need to carry out further evaluation of the guidelines in order to gain feedback regarding their content from a range of different groups. The primary objective of the current study was to evaluate the guidelines with a range of human factors experts, parents of young children, teachers and professional book illustrators and authors.

1.2. Methodological considerations when carrying out research with young children

Carrying out research with young children often proves to be challenging. With children aged 6–7 or under, interviews are difficult to carry out, particularly since children of this age group find it difficult to respond to direct questions about themselves (Backett and Alexander, 1991; Mauthner, 1997). Waterson et al. (2012) found that talking to the younger children in small groups proved to be successful when it was structured around themes and topics which may be of interest to them (e.g., their experience of train travel). In the case of both younger and older children it was important to make the activities fun and interesting for the children. Part of this involved setting out strategies for introducing the researchers and the topics we were interested in (e.g., by using characters and activities for the children to do). The use of a classroom setting and the presence of a teacher also meant that the workshops were not threatening or otherwise intimidating for the children. In general we tried as much as possible to equalize any differences in power relations that may have existed between the researchers and the children. One way of doing this was to ask open-ended questions and allow the children to set their own agenda when evaluating the signs. In some cases this can mean that the children get distracted and the data may prove to be not very useful. In other cases, it had the advantage that it allowed the children to fully express themselves without any fear or inhibitions. On the basis of these and other observations, a second set of guidelines covering the evaluation of warning signs was developed by Waterson et al. (2012, Table 2).

1.3. Study aims and objectives

The chief aim of the present study was to evaluate both sets of guidelines covering design and evaluation developed in the earlier study. The guidelines were developed largely on the basis of a set of discussion sessions held with children in their classrooms and facilitated by the researchers and teachers. The aim of the current study is to firm up the guidelines by drawing on the opinions of a wider range of people (e.g., human factors experts, parents and children's book illustrators). A second objective was to develop a revised set of guidelines which could be used by designers to develop new signs and later evaluated and tested with children and other groups (e.g., parents, teachers).

2. Methods of study

2.1. Participants

The study was conducted between January and May 2012 and involved two methods of study: a set of 11 individual semi-

Table 2
Summary of the evaluation guidelines developed by Waterson et al. (2012).

Guideline	Details
1. Preparation	Working with children can be challenging and it is essential to pilot materials and activities with small groups before using them to carry out design or testing. A process of iteration and refinement of the content and format of materials/activities and obtaining feedback from children, parents/carers and teachers is strongly recommended. Time spent gathering ideas and trying out activities with parents and teachers is very likely to be well spent.
2. Setting	A setting which places the children at ease and the activity can be integrated into normal, daily life is recommended. We found that a familiar setting such as the classroom worked well within our study. In other cases, playgroups or afterschool clubs may also be worthwhile considerations for design/testing activities.
3. Participants	Children, particularly young children are likely to be shy when in the presence of other adults they do not know. It is worthwhile including a parent or teacher in the study group. The presence of an 'authority' figure can be reassuring for the children and reduce any anxieties they may have. It can also help to maintain discipline when children find it hard to focus on a particular task or when individual children dominate group tasks and the views of quieter children are not allowed to be heard.
4. Methods	We found that the children in our study responded well to classroom discussions rather than a focus group format. They found the discussions to be fun and interesting. Small focus groups may be useful with older children, particularly when prototype designs are well advanced and more specific aspects of the design need to be tested. The use of open-ended questions also helps to stimulate discussion amongst children and may help to generate useful, sometime unexpected design suggestions.
5. Activities	For younger children it is worthwhile integrating design/testing into a story-like format. Younger children often think in terms of stories and enjoy them. Stories also may facilitate their understanding of the task and help them to generate ideas.

Table 3
Data collection: composition of interviews and focus groups and participant background.

Method of investigation		Participant background	Number of participants
Semi-structured interviews		Human factors researchers and consultants	7
		Children's book illustrators	2
		Film producer	1
		Teachers	1
Focus groups	Focus group 1	Parents	9
	Focus group 2	Teachers	5
	Focus group 3	Teachers and parents	6
	Focus group 4	Parents	2
	Focus group 5	Human factors researchers and consultants	3
	Focus group 6	Children's book illustrator and author	2
			Total = 38

structured interviews and six focus groups involving 27 participants. Table 3 outlines the composition and background of participants taking part in the interviews and focus groups.

Ten of the participants had a background in human factors research (e.g., rail and transport safety), three of these researchers had previous experience in human factors research involving children (e.g., child anthropometrics, consumer product design). Thirteen participants were parents of young children. Nine of the participants were employed as teachers in UK primary schools (i.e., schools where pupils are aged 4—11). Four other participants worked as illustrators or graphic designers for book publishers. One additional participant was employed as a film producer and had been involved with the 'Play it Safe' campaign to reduce children's accidents in the home during the 1980s (Jackson, 1983).

Focus groups were selected as a method of data collection since they provide an opportunity for participants to discuss and react to one another's views, thus promoting greater diversity of ideas and feedback to the researcher (Kitzinger, 1994). Focus groups are also a convenient method of sampling a full range of perspectives (Powell and Single, 1996). The focus groups lasted approximately 90 min and involved between 2 and 9 people. Participants were seated in a circle as recommended by Powell and Single (1996) since this format maximises face to face contact. Paraphrasing was used to ensure that the notes taken and the information on the digital tape recorder represented the participant's true opinions (Robson, 2002).

2.2. Procedure

The study procedure followed three main stages (Fig. 1). These stages were common to both the semi-structured interviews and the focus groups.

Following briefing and obtaining study consent from participants, interviewees were asked a set of questions regarding their previous experience with children's safety and warning signs (Stage 1). Questions probed what signs participants were aware of, where they had seen these and their purpose. In addition, interviewees were asked about the specific features of signs and warning which they considered to be important as part of the content and general design of safety signs and warnings. The prime purpose of Stage 1 was to generate information about children's signs without a feeling of being constrained by the guidelines developed earlier, or prompted by current signs shown to them later. Stage 2 involved participants evaluating each of the design guidelines developed by Waterson et al. (2012, Table 1) and discussing the strengths, weaknesses and suggestions for improvements for each guideline. Participants were then shown a set of signs currently in use within the UK. These signs were drawn from examples of rail safety warnings commonly found on trains or at train and underground stations. In addition, participants were also shown examples of the signs which were developed as part of the Waterson et al. (2012) study. The purpose of this phase of the data collection was to use the signs to prompt comments and stimulate discussion by participants. Figs. 2 and 3 show examples of the signs which were shown to participants.

Finally, the Stage 3 involved participants evaluating each of the evaluation guidelines developed by Waterson et al. (2012, Table 2) and discussing the strengths, weaknesses and suggestions for improvements for each guideline. In addition, participants were asked about their ideas and suggestions for methods for evaluating warning signs and other visual information for young children.

2.3. Data analysis

All of the interviews and focus groups were recorded using a digital recorder and manually transcribed into Microsoft Word documents. The data was then inputted into the NVivo (version 7) qualitative data analysis software package. Template analysis (King, 1998; Crabtree and Miller, 1999) was used to further examine and develop codes using a set of *a priori* codes based upon the interview and focus group questions and the design and evaluation guidelines. Once the *a priori* codes had been defined they were subsequently applied to the whole dataset. During the second phase of data analysis the original codes were reanalysed and a number of
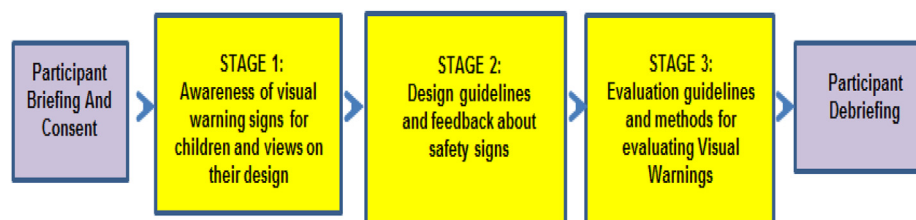

Fig. 1. Semi-structured interviews and focus group procedure.

Fig. 2. Examples of railway signs in use within the UK.

additional themes and sub-themes emerged from the data. This process followed the guidelines outlined by Miles and Huberman (1994) and aimed to establish consistent coding schemes (Robson, 2002). The codes were developed independently by both authors and then compared and discussed. A final set of codes for the interview and focus groups emerged out of these discussions.

3. Findings

3.1. Stage 1: awareness of visual warning signs for children and views on their design

In general, participants showed a good deal of awareness of locations and places where they had encountered warning signs for children. Examples included outdoor centres, swimming pools, traffic signs and labels on products and packaging. Recall of the details of specific signs proved harder however. Some participants were able to describe in detail signs designed to encourage hygiene (e.g., hand washing) and safe behaviour on playgrounds. Participants in the interviews and focus groups often talked about signs in relation to current or past safety campaigns aimed at children. These included campaigns targeted at road safety (e.g., the UK Department of Transport, Think! Campaign and the associated Green Cross Code aimed at 5- to 7-year olds — Department of

Transport, 2012; the UK Royal Society for the Prevention of Accidents use of the Tufty the squirrel character — RoSPA, 2012; Firth, 1973), as well as campaigns focused on accident in the home and rail travel (e.g., The 1980s 'Play it Safe' campaign — Jackson, 1983).

Participants were asked to list what features they deemed to be important on safety signs. The most frequently used words to answer this question were: colour(s) (17), character (9), simple (8), and understand/attention (6). Fig. 4 shows a tag cloud of these suggestions.

Fig. 3. Examples of signs developed as part of Waterson et al. (2012).

Fig. 4. Tag cloud showing participants views on important features of safety signs.

Some participants emphasised the need for colours to build on the natural associations children have with the circumstances they associate with danger and hazards (e.g., the colour 'red' signals 'danger'), whilst others stressed the need for colours to use a limited set of colours, rather than make signs too 'busy'. A common observation was the need to be aware of the prevalence of colour blindness and the problems involved in using some colour combinations (e.g., red–green pairings).

The use of characters, cartoons and other pictorial material was mentioned a number of times during the interviews and focus groups. Characters from television and other media (e.g., the action character 'Ben 10') alongside the use of images which were perceived to be familiar, engaging or comforting to young children (e.g., teddy bears, hedgehogs) cropped up in discussions. One participant highlighted the value of using symbols used to teach specific groups of children (e.g., hearing impaired children). Fig. 5 for example, shows an of the sign language symbols used in the Makaton system (The Makaton Charity, 2012).

The importance of keeping up-to-date with trends and changes was also stressed alongside the importance of using characters and images which were immediately recognisable and identifiable: "*there's not a child on the planet that can't spot the M in the McDonalds and the tick* [used with the Nike brand], *you don't even need the word for Nike because you have the tick*" (Focus Group 3 – Parents and Teachers).

A number of participants stressed that young children vary a great deal in their ability to comprehend information (e.g., ability to read simple words) and that designing for the age group 5–11 needs to take these factors into account: "*My children are starting to recognise words like cat, dog that kind of word. Some of the kids are very good and they can read simple vocabulary, some of them can't read at all*" (Interview – Teacher). One participant (a film producer with experience in making television safety programmes for children) emphasised that younger children respond better to animal characters, as compared to older children who are more likely to identify with characters representing children or adults. The need for simplicity in terms of the pictorial and textual aspects of the signs was stressed a number of times. The need for '*one glance understanding*' (Interview – Illustrator) and the avoidance of relying solely on words, was emphasised: "*I would imagine your first objective would be to avoid words altogether, it may not be possible, it all depends on what you are trying to put over and say. … try to do it pictorially*" (Interview – Illustrator). Finally, the importance of designing for children with disabilities, special needs or visual impairment was repeatedly stressed by participants. A significant proportion of the child population is dyslexic or speak English as a second language. These types of considerations underlined the need to avoid language as much as possible when considering the components of visual signs.
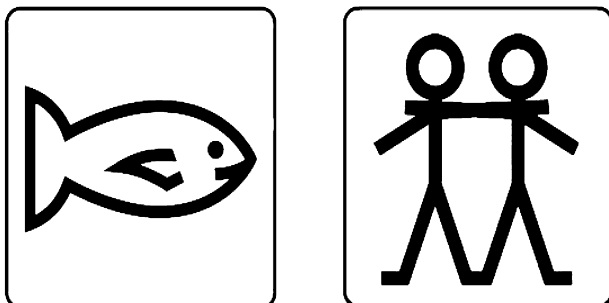

Fig. 5. Examples of Makaton symbols ('fish' and 'friend').

3.2. Stage 2: feedback on design guidelines and safety signs

In general, there was support for the design guidelines (Table 1), however, a number of participants felt that more details could be included and some modifications were needed. Most participants found Guidelines 1.i (preparation) and 1.ii (design and evaluation) useful, however some felt that these were more applicable to designers and illustrators, as compared to human factor researchers: "*It's not particularly unique to testing a sign so it depends who the audience are. As a person that does research work, I would already know that*" (Interview – Human Factors Researcher).

In other cases, it was felt that these guidelines had value, but needed to be extended and complemented by an overview of the design lifecycle and an indication of where each guideline applied to stages in the lifecycle: "*it would be useful to almost have a flowchart*, [in other words] *this is how you go about developing* [safety signs for children] *… it would be helpful if they were put in sequence*" (Interview – Human Factors Researcher). It was also pointed out that the design of signs and other visual material for children is often a team effort and that more specific guidance linked to design lifecycles, phases etc., might help to establish continuity between team members over time and handover between different specialists within the team. The general function of the guidelines as a whole was questioned a number of times by participants. One of the central questions was the intended audience of the guidelines and the need to tailor their content to this audience: "*Who are the guidelines for? Who are the intended audience? … I'd expand some of those statements to be a little more prescriptive*" (Focus Group – Human Factors Researchers).

A similar comment from one of the illustrators was that the need to set the guidelines within a design context where designers often worked under a great deal of time and budgetary pressure. The guidelines needed to be more direct, punchier and tailored to the day-to-day 'working world' of the illustrator or designer: "*You need to be able to glace at something once and understand* [straight away] *… you don't stop to read things when you are a designer*" (Interview – Illustrator). This comment was reinforced by other groups who had experience in designing safety signs for trains: "*you've got to make it so the designer can do their job … It's about getting that process to be concise and quick enough and easy enough …*" (Focus Group – HF Experts). One of the interviews with an illustrator revealed that one of the main functions of the guidelines should be to provide support and prompt ideas for the content of the warning sign. The description of the process of illustrating a children's book showed that much of the process the illustrator used was relatively ad-hoc, ill-structured and informal: "*I would normally target it with 2 or 3 friends just around the house just very quickly, what's that? Do you like that? I would then go out I would probably find someone who has children from a friend group*" (Interview – Illustrator).

Guideline 2.i (types of signs) was viewed as being helpful, but in need of expansion and positioning in a larger context: "*Signage should be developed in association with the environment/product/equipment you are developing so that it matches what the gaps are. … If you retro fit a sign … in the wrong place, it's not going to work.*" (Interview – HF Expert). An important part of the context of use was the location of the sign and the need for the sign to be within the child's line of sight. Guideline 2.iii (Language) was seen as important, but in need of additional considerations (e.g., variation in reading ability, children with English as a second language). One of the participants mentioned a book which shows examples of signs (Hoban, 1983) which can be read by pre-school children before they have been formally taught to read (i.e., children recognise, rather than read the words – examples include words such as 'Playground' and 'Walk').

Guidelines 3.iii (number of words) and 3.iv (use of terminology) elicited a number of comments inline with those described in Section 3.1 (e.g., the importance of minimising the number of words, using simple language). One participant commented on the 'Mind the Gap' poster (Fig. 2c) in order illustrate the way in which misunderstandings might occur with younger children: "… *that doesn't show the gap does it? A small child might just simply think that is someone running to catch the train or dancing*" (Interview − Illustrator).

The guideline addressing fonts and lettering, 3.v, received the most criticism from participants. Many pointed out that within the UK children typically learn to read lowercase letters first and then only progress at a later stage to capitals (Department of Education and Skills, 2006). Uppercase may work with signal words such as 'STOP' but the use of bold and exclamation marks were preferred for emphasis. When selecting fonts for use on signs it is important to consider the shape of the letters − they should be as similar as possible to those that children learn. A suggestion from one of the teachers and an illustrator was to use the comic sans font as this displays the letters in a form which is easy for children to read and learn. Some participants requested that more information was available on the size of fonts and viewing distances. This information is available for adult's signs (e.g., RSSB, 2003), but equivalent data for children is much harder to find.

Guidelines 4.i (pictograms) and 4.ii (examples) were viewed as important and received support by participants. The question of whether to show examples of good and bad behaviour in the same sign generated some discussion amongst participants. Many felt that showing bad behaviour might encourage children to try out the action in the sign: "*Some* [children] *would think look there's the bad behaviour I hadn't thought about it lets go do that … look what I*

can do, I can swing off the rails rather than oh look I can sit sensibly on the train" (Interview − Teacher).

Guidelines 4.iii (symbology), 4.iv (characters) and 4.v (colours) received support from participants. Many of the comments reinforced statements made in Section 3.1 above. Some of the characters shown on the signs developed in our earlier work involved the use of monsters and 'gargoyles'. These were seen to be potentially frightening to very young children and it was recommended that they be replaced with 'friendly' characters. Some of the participants recommended that a consistent set of characters were used in signs, these could serve to reinforce the intended message and could be memorised by children (Young and Wogalter, 2001). The positioning of characters within the overall sign was highlighted as important: "*We thought very carefully about where the text was going to be and certainly in programmes* [TV programmes in the 'Play it Safe' campaign] *I made later*" (Film Producer).

3.3. Stage 3: feedback on evaluation guidelines and methods

The comments made by participants on the evaluation guidelines (Table 2) were broadly positive. Most of our sample found the information and suggestions for methods and activities to be helpful and capable of providing support for sign evaluation. Most of the comments related to additional activities and considerations which should be taken into account during evaluation. One observation which cropped up a number of times was that evaluation should be seen within a wider context and not simply restricted to warning signs. Participants described the value of evaluating signs as part of larger effort of understanding the impact of larger safety campaigns involving a range of activities and media (e.g., school visits, use of websites, information leaflets). In common

Table 4
Modifications and additions to the design guidelines (additional guidelines in grey, other changes in italics).

Guideline	Sub-component	Details
1. Working with children	(i) Preparation	Pilot, test and evaluate your methods thoroughly
	(ii) Design and evaluation	*Working with children can be challenging*, be prepared to be surprised by what you find (they may contradict your assumptions)
2. Target audience	(i) Safety campaigns	If the sign within a larger safety campaign, how would the sign complement or fit into other aspects of the campaign (e.g., consistency in terms of colours, characters etc.)?
	(ii) Additional supporting materials	Consider the use of other media to support safety signs (e.g., leaflets, websites, TV programmes)
	(iii) Age	What age range does target audience fall into? What are their reading levels (very young children (<7 years) will have low levels of reading comprehension)?
	(iv) Cultural, national factors	Cultural and national factors may impact the comprehension of signs (e.g., interpretation of characters, symbols; language comprehension − e.g., children learning English as a second language)
	(v) Special needs and disabilities	Some children may have learning disabilities which may need to be taken into account; a significant proportion of children are colour blind
	(vi) Gender	What is the gender mix of the target group? Gender may influence the degree to which characters, colour and symbols are interpreted and comprehended
3. General format	(i) Type of signs	Design the sign with objectives and context of use in mind
4. Textual aspects	(ii) Language	*Avoid the use of text in signs where possible; where this is not possible*, keep the language used in signage as simple as possible.
5. Textual aspects	(iii) Number of words	Use a minimum of words
	(iv) Use of terminology	Avoid 'abstract' concepts or terminology
	(v) Fonts and lettering	*Use lowercase lettering and consider the use of uppercase for important (signal) works (e.g., STOP); consider the use of fonts which children find easy to read (e.g., Comic Sans); consider the size of the text to be used*
6. Visual aspects	(i) Pictograms	Use pictograms where possible to reinforce the safety message; *keep these simple*
	(ii) Examples	*Use examples of pictograms which primarily demonstrate 'good' (i.e., safe and correct) behaviour; examples of 'bad' behaviour may also be appropriate, but be aware that they may encourage children to copy the behaviour shown*
	(iii) Symbology	Use symbology that appeals to children; *consider the use of symbols which are easy to comprehend (e.g., Makaton symbols)*
	(iv) Characters	Use safety characters to help convey the safety message; *consider the use of characters which may be topical and popular with children (e.g., TV characters); avoid the use of characters which may be perceived as frightening to very young children (e.g., monsters)*
	(v) Colours	Use *bright* colours to reinforce the safety message; *consider some of the association young children may have with colour (e.g., 'red' for 'danger'); be aware that some children may be colour blind*
7. Location	(i) Height	Position the sign in the line of child's line of sight
	(ii) Positioning	Position the size where it is likely to be noticed by the child and not obscured or easily confused with other objects; consider the positioning of the components of the sign (e.g., pictograms, text)
	(iii) Size	Make the sign large enough to be noticed within its location

with the evaluation of the design guidelines, participants also emphasised the value of positioning the guidelines within a broader design context which corresponded to the stages and activities typically undertaken by designers and illustrators. Examples of what this might look like included current guidelines (e.g., ANSI, 2011; ISO, 2008, 2011) for the design of signs for adults. At the same time, it was acknowledged that the types of evaluation carried out within the guidelines might be difficult with young children (e.g., one-to-one testing of comprehension), but might work with older children (i.e., 8+).

A second set of comments related to the need to underline the importance of the context in which the signs would be positioned, located and used (Guideline 2 − setting). Participants stated that in many instances it was difficult to judge the suitability of a design (e.g., the sliding doors warning signs − Fig. 2a and b) without knowing more about the context. One way of achieving this was to attempt to either simulate the context or carry out evaluation *in situ*: "*Couldn't you try and set up a train or something like that with the doors … you'd invite children in to a mock-up train station with the train*" (Focus Group 3 − Parents and Teachers). Acting out the roles either in the classroom or a real situation (e.g., talking the children on a trip to a train station) and possibly asking teachers or parents to dress up and make the activity fun to children was also mentioned: "*It might be worth considering someone who is an actor who could may be portray different roles, being a train guard or whatever situation*" (Interview − Illustrator). The role of storytelling featured in some participant's comments (Guideline 5 − activities), particularly as a means of establishing some context for the sign: "*you would start a conversation about whose ever been on a train, who knows about different trains. Look at these pictures what sort of train is this?*" (Focus Group − Parents and Teachers). Additional materials such as videos, photographs, multiple-choice tests were also suggested as ways of complementing role playing and storytelling. The inclusion of rewards and incentives was also thought to be worth considering (e.g., giving out stickers and badges for taking part in role-playing exercises).

A number of additional points were made including the comment that the guidelines assume a relatively passive role for children in the evaluation activities. One participant (a teacher) pointed out that within her school, some of the children had been involved in designing safety posters and that their designs had hung on the walls of the school (e.g., a poster warning children not to run in school corridors). A related comment was that children should be regarded as designers themselves and the activity of designing could be included as part of design and evaluation activities. Many participants commented that many warning signs are not designed with children in mind: "*The ones that are in schools are very highly specialised and specific … The ones on trains they're not designed for children,*" (Interview − Illustrator). One reason for this was that younger children, particularly those less than 7, are most likely to be accompanied by a parent or guardian when they first encounter a sign. In these contexts it may be that adults and children are likely to interpret the meaning of a sign together: "*if you are designing for the children, you are designing for the adult with the child*" (Interview − Illustrator). A final set of comments emphasised the need to treat young children with respect and not to patronise them: "*I would make sure that you talk to them like a real person, don't talk down to them …* " (Interview − Teacher); "*Children are very quick to take offense and children always believe they are older than they are.*" (Interview − Illustrator).

4. Discussion

The data from the interviews and focus groups provided a good deal of feedback and further information as regards the

content and format of guidelines for the design and evaluation of warning signs. We should also note, however, that there is a need to apply and evaluate the guidelines to a wider range of contexts. Our work focused specifically on rail and transport warnings and there is a need to examine their suitability for other types of signs which involve children (e.g., consumer goods). Section 4.1 focuses on modifications to the content of the guidelines. In Section 4.2 we discuss how the guidelines could be further developed in order to support the work of designers, illustrators and other groups.

4.1. Revisiting the original guidelines

Much of our data provided a degree of confidence that many of the original guidelines were appropriate and useful in helping to support design and evaluation activities. At the same time the data pointed to a clear need for additional support, as well as

Table 5
Modifications and additions to the evaluation guidelines (additional guidelines in grey, other changes in italics).

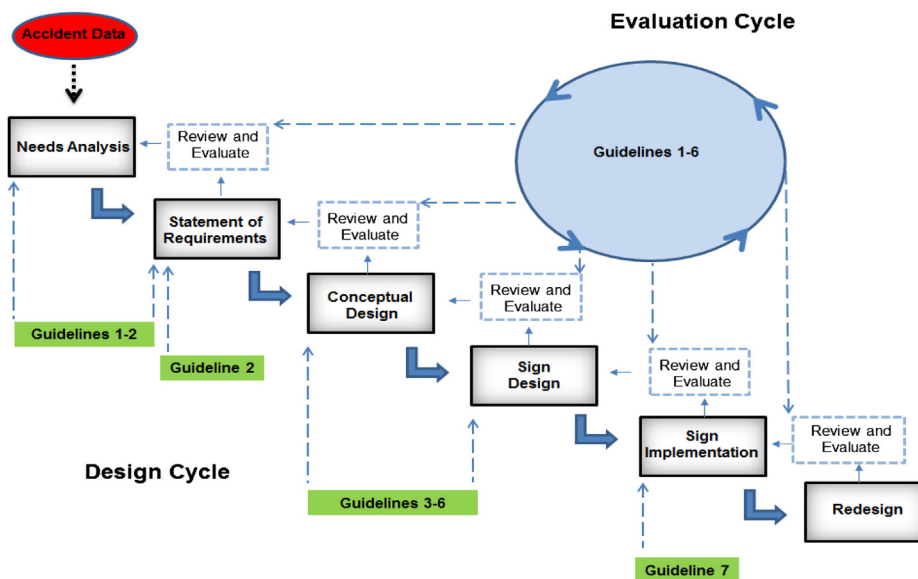| Guideline	Details
1. Working with children	Working with children can be challenging − thorough evaluation and testing are imperative. Designing for children is very different from designing for adults. Treat children with respect as they are easily offended.
2. Preparation	Working with children can be challenging and it is essential to pilot materials and activities with small groups before using them to carry out design or testing. A process of iteration and refinement of the content and format of materials/activities and obtaining feedback from children, parents/carers and teachers is strongly recommended. Time spent gathering ideas and trying out activities with parents and teachers is very likely to be well spent.
3. Setting	A setting which places the children at ease and the activity can be integrated into normal, daily life is recommended. We found that a familiar setting such as the classroom worked well within our study. In other cases, playgroups or afterschool clubs may also be worthwhile considerations for design/testing activities.
4. Participants	Children, particularly young children are likely to be shy when in the presence of other adults they do not know. It is worthwhile including a parent or teacher in the study group. The presence of an 'authority' figure can be reassuring for the children and reduce any anxieties they may have. It can also help to maintain discipline when children find it hard to focus on a particular task or when individual children dominate group tasks and the views of quieter children are not allowed to be heard.
5. Methods	*A variety of methods for testing and evaluation are possible, some of these will depend on the age of the target group, as well as other concerns such as the time available for testing/ evaluation. One way to test signs is to attempt to <u>mock-up</u> or <u>simulate</u> the environment in which the sign will be situated (e.g., the interior of a train, a leisure centre or playground). Alternatively, it may be worthwhile carrying out a <u>role-playing</u> exercise, where a parent or teacher may be able to act out some of adult the roles alongside children. Young children also respond well to <u>classroom discussions</u> rather than a focus group format. They found the discussions to be fun and interesting. Small <u>focus groups</u> and <u>interviews</u> (accompanied by a parent, guardian or teacher) may be useful with older children, particularly when prototype designs are well advanced and more specific aspects of the design need to be tested. The use of open-ended questions also helps to stimulate discussion amongst children and may help to generate useful, sometime unexpected design suggestions.*
6. Activities	*For younger children it is worthwhile integrating design/ testing into a <u>storytelling</u> format. Younger children often think in terms of stories and enjoy them. Stories also may facilitate their understanding of the task and help them to generate ideas.*

Fig. 6. Flowchart of design and evaluation activities (based partly on Keates and Clarkson, 2004, p. 154).

modifications to the wording and sequencing of specific guidelines. In particular, a new phase/component ('working with children') has been added and covers the sub-components 'preparation', design and evaluation', as well as guidance covering 'safety campaigns' and 'supporting materials'. Additional guidelines covering 'target audience' were also added as quite a lot of our data mentioned some of the variables which might influence the role played by attention, comprehension and attitudinal factors (Wogalter et al., 1999, 2002) amongst young children (e.g., age, gender). Guidelines covering the location (height, positioning and size) of signs was also added, these were included in order to accommodate some of the physical and anthropometric factors which should be taken into account during design. Finally the specification of a number of guidelines was improved and further information provided in order to either make them more prescriptive or illustrative (i.e., through the use of examples). In some cases, guidelines were completely revised in the light of our data and other background material (e.g., the use of lowercase as opposed to uppercase lettering).

Similar changes were made to the guidelines as they apply to evaluation (e.g., an additional guideline was added covering 'working with children'). Most of the changes relating to the evaluation guidelines concerned greater provision for examples of methods which could be used to evaluate or test signs. Tables 4 and 5 outline the revised set of guidelines and the changes which we made in the light of our findings.

4.2. Tailoring the guidelines to the needs of designers, illustrators and other groups

One of the clearest messages from our data was the need to provide additional guidance for those groups responsible for carrying out the design of warning signs (e.g., a flowchart setting out the timing and relevance of each guideline). During the current study it became clear that human factors groups represent only one part of the challenge of improving warning signs for children and other groups including managers, illustrators and graphic designers, are involved. Moreover, the involvement of these groups varies over time. As one of our participants stressed, one person may be involved during design phases and a second in testing/evaluation. Designing guidelines which support the

diversity of these groups and their background knowledge of human factors, to a large extent involves not only support in the form of guidelines, but also the process and lifecycle of design/ evaluation activities as they take place over time. Fig. 6 (based partly on Keates and Clarkson, 2004, p. 154) represents an attempt to integrate the guidelines with stages and design/evaluation phases within a more comprehensive, lifecycle-based approach to sign design.

5. Future work and conclusions

Much of the guidance which is available is anecdotal in nature and current lacks an evidence base which draws upon scientific studies. The current Think! Road safety campaign in the UK for example (Department of Transport, July 2011), recently reported an evaluation of materials used in schools which was largely based on feedback from websites. Some of the material related to the design of safety posters, but reported few details of how the data was gathered or the rationale underpinning design recommendations. The revised guidelines described in this paper represent a step forward; however, there is a need for much more work in this area. In particular, we would point to three main areas for future research: development of a more comprehensive guide for the design/evaluation of children's warning signs (Section 5.1); the need for behavioural evaluation (Section 5.2); and, establishing a wider context for design/evaluation (Section 5.3).

5.1. Development of a more compressive guide for the design/ evaluation of children's warning signs

The guidelines described in Tables 4 and 5 could be further developed and extended. A primary need is to evaluate their use in actual design (i.e., use the guidelines to develop new signs and then test them once again with children, parents and other groups). This type of activity might be able to highlight gaps and the need for further information. A longer-term goal would be to develop a guide which is similar to those available for inclusive sign design (e.g., Barker and Fraser, 2000), as well as other the design of types of visual information (e.g., the labelling and packaging of medicines — NPSA, 2008). These guides often present guidelines in the form of an issue or design component (e.g.,

colour) alongside a detailed example of how this might be realised in the form of an example design. The use of design personas (Grudin and Pruitt, 2002) and the development of a toolkit for design might also be considered. In combination with further support along the lines of that described in Section 4.2 (Fig. 6), these materials might provide firmer and more illustrative support to the various groups involved in sign design for children, as well as incorporating sound, evidence-based human factors advice. We should note, however, that based on our experience with working with children, it is likely that such materials will not contain as much definitive or prescriptive guidance as compared to design for an adult population. Designing for children requires more flexibility.

5.2. The need for behavioural evaluation

Our findings also underlined the fact that young children are unlikely to interpret the meanings of signs on their own. Rather, comprehension and interpretation are likely to be joint processes involving interactions with adults and other care givers. In many respects, models of sign comprehension and communication (e.g., the C-HIP model – Wogalter et al. 1999) will need to be modified to accommodate adult–child interaction and involvement in the process of building a negotiated mutual understanding of the sign (c.f., Edwards and Mercer's work on mutual understanding in the classroom – Edwards and Mercer, 1987). In order to examine this further there will be a need to carry out observational (ethnographic) research within the context in which a sign is being used. This type of behavioural evaluation presents a number of challenges (e.g., establishing naturalistic as opposed to artificial situations in which observations can be carried out), however, it is not impossible (Kashler and Wogalter, 2008).

5.3. Establishing a wider context for design/evaluation

A final area for future work is the need to view signs within the context of larger safety concerns including safety campaigns and their design. Signs should not be seen within a 'stand-alone' context, they often form the basis of one component within a much larger campaign. Future work should concentrate on examining and evaluating the role played by signage within this larger context. Few of these types of studies exist and sometime demonstrate that campaigns perceived to be effective often fail to get the safety message across to children (e.g., Antaki et al., 1986). Finally, the increasing influence of new technologies and the possibilities these afford for presenting information in different ways (e.g., context sensitive, sensor-driven, ambient warnings), needs to be addressed as part of a longer-term programme of research on children's warning signs (Wogalter and Mayhorn, 2006).

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